

# STRUCTURE OF MICROCARD

A01/1 = Structure of microcard

A03/1 = Special features, general,  
safety precautions, test bench  
accessories, test specifi-  
cations, tightening torques

B01/1 = Testing

N26/1 = Index

N27/1 = Table of contents

N28/1 = Editorial note

Continue: A02/1 Fig.: A01/2

	1					2				
	12345	67890	12345	67890	12345	678				
	SIS									
A	XXXXX	XXXXX	XXXXX	XX						
B	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXX				
C	XXXXX	XXXXX	XXXXX	XXXXX	XXXXX	XXX				
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Continue: A02/1

## STRUCTURE OF MICROCARD

The user prompting appears on every page, e.g.:

- Continue: B17/1
- Continue: B18/1    Fig.: B17/2

.../1 = upper coordinate half

.../2 = lower coordinate half

Continue: A03/1

## NOTES ON TESTING OF FUEL-INJECTION PUMPS

### General.

The test instructions contain all the data and information required for the adjustment of size F 10 fuel-injection pumps.

Further information on test equipment and calibrating oil is given in the respective test-specification sheet.

The described sequence of operations corresponds to the data sequence in the test specifications.

The delivery rates quoted always represent the average value for all plunger-and-barrel assemblies of a fuel-injection pump.

Continue: A03/2

## NOTES ON TESTING OF FUEL-INJECTION PUMPS

The prescribed difference in delivery rate applies to the individual plunger-and-barrel assemblies of a pump.

Specified control-rod travels are set and measured with the appropriate control-rod-travel measuring device.

Check values for speeds, delivery rates and differences are given in brackets. They only apply in the as-delivered condition of an injection-pump assembly and are n e v e r to be used for readjustment.

Continue: A04/1

## TEST SPECIFICATIONS

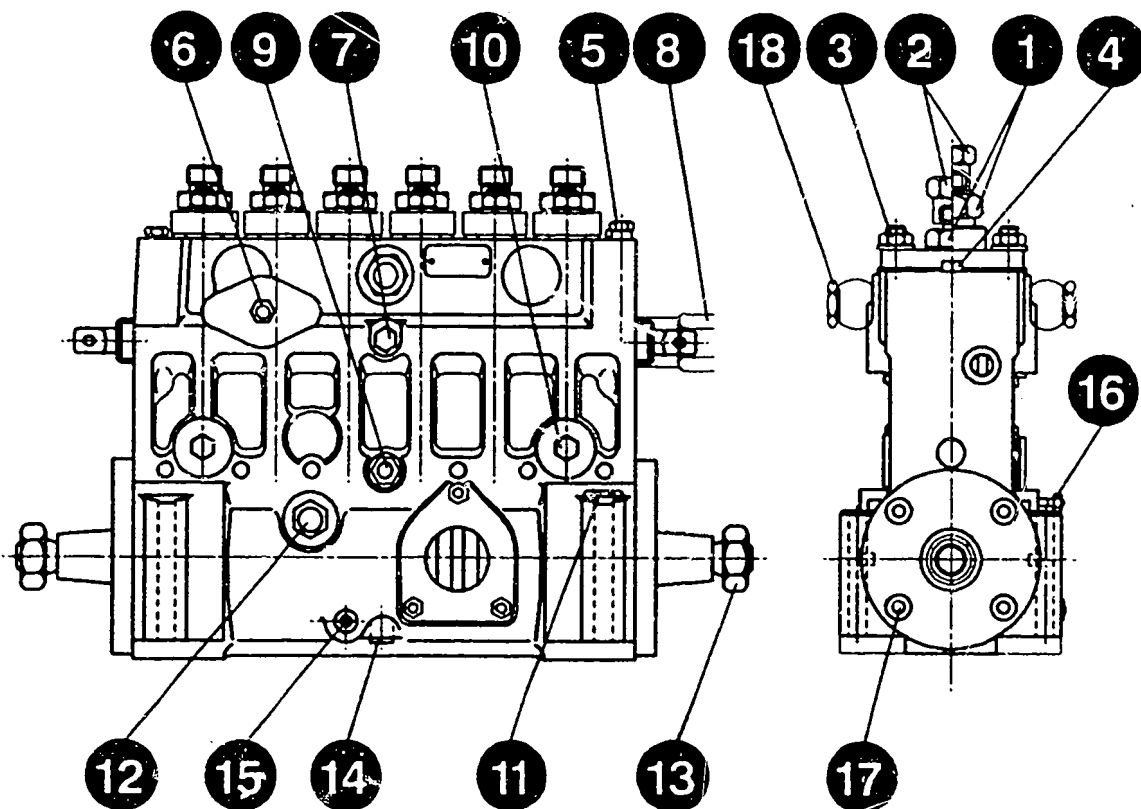
The test specifications for fuel-injection equipment are contained in the test specifications in the micro-cards WP..

Continue: A05/1

# TIGHTENING TORQUES

- |                                    |                          |
|------------------------------------|--------------------------|
| 1 = Delivery-valve holder          |                          |
| with flat seal ring and gripp-     |                          |
| ing edge:                          | 180...200-0-160...180 Nm |
| with flat seal ring and beaded     |                          |
| seal ring:                         |                          |
| 180...200-0-180...200-0-38...42 Nm |                          |
| + 20...21 Grad turn-on angle       |                          |
| with two gripping edges (no seal   |                          |
| ring)                              | 160...180 Nm             |
| 2 = Union nut                      | 38...45 Nm               |
| 3 = Hexagon nut                    | 51...58 Nm               |
| 4 = Screw plug                     | 5...7 Nm                 |
| 5 = Screw plug                     | 5...7 Nm                 |
| 6 = Inlet-union screw              | max. 8 Nm                |
| 7 = Hexagon bolt                   | 8...11 Nm                |

Continue: A06/1 Fig.: A05/2

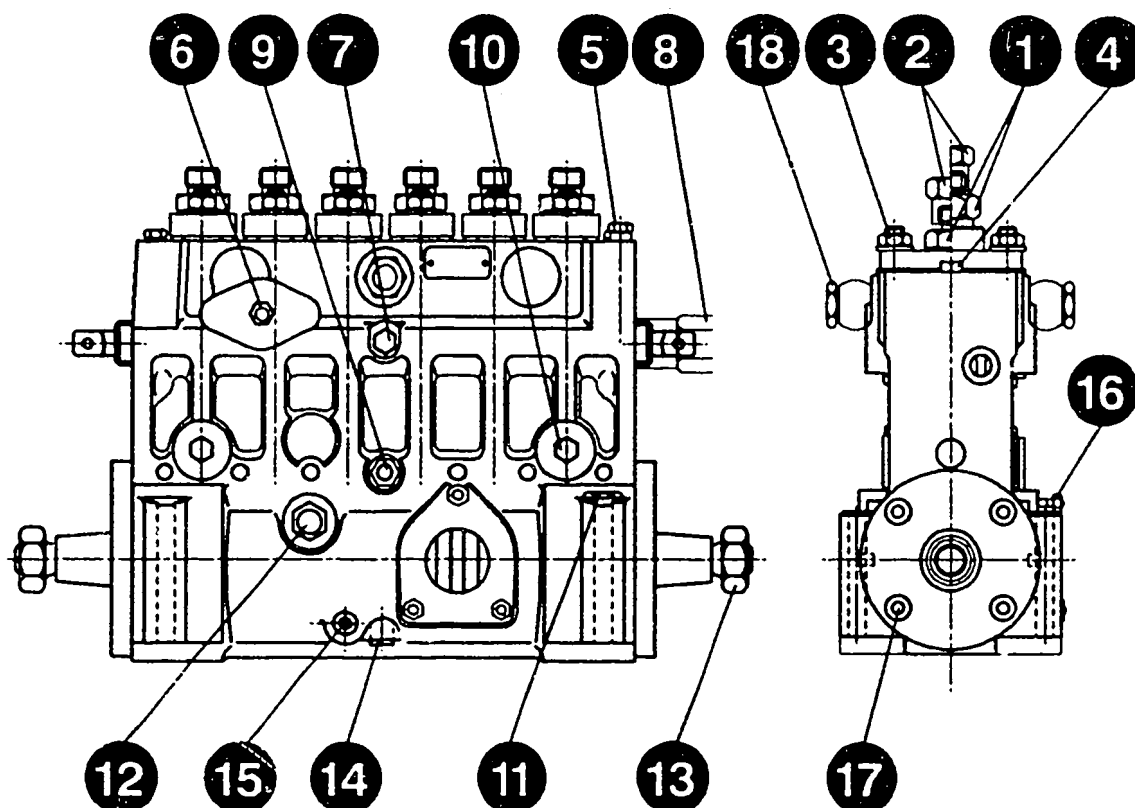


KMK02393

# TIGHTENING TORQUES

8 = Control-rod plug		max. 30 Nm
9 = Hexagon bolt		max. 12 Nm
10 = Screw plug		30...50 Nm
11 = Hexagon bolt		25...35 Nm
12 = Scw connection	19 mm	max. 24 Nm
	24 mm	max. 42 Nm
13 = Couplings and timing device		
Hexagon nut	19 mm	60...75 Nm
	27 mm	130...150 Nm
	30 mm	200...240 Nm
	36 mm	250...300 Nm

Continue: A07/1 Fig.: A06/2

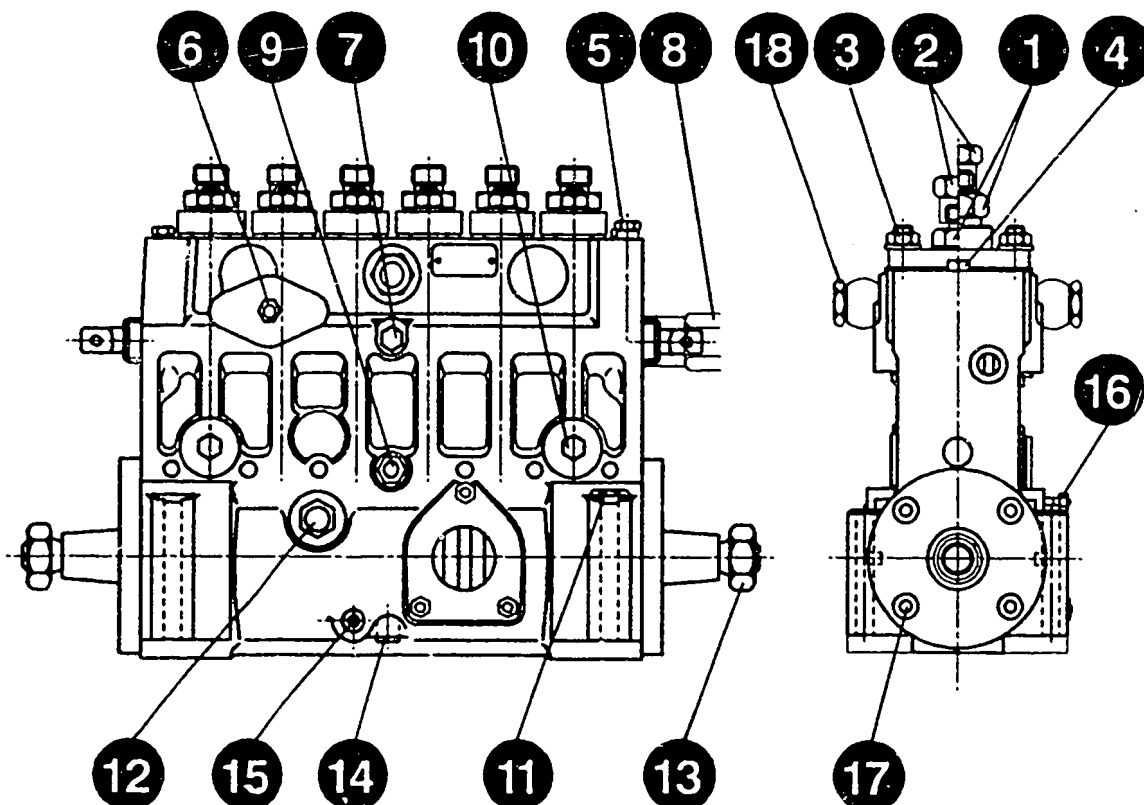


KMK02393

# TIGHTENING TORQUES

14=	Fillister-head screw for intermediate bearing	
	6 mm with Cu seal ring	
	8x11.5x1 mm	14...16 Nm
	5 mm with O-ring and washer	22...24 Nm
	5 mm with Cu seal ring	
	8x13x1.5 mm	22...24 Nm
15=	Screw plug	14...16 Nm
16=	Hexagon nut	5...7 Nm
17=	Fillister-head screw	18...22 Nm
18=	Inlet-union screw 19 mm	max. 24 Nm
	24 mm	max. 42 Nm

Continue: A08/1 Fig.: A07/2



KMK02393

## SAFETY PRECAUTIONS

In addition to the safety instructions given in the operating manuals for Bosch injection-pump test benches, attention is to be paid to the following safety precautions:

1. Never test damaged fuel-injection pumps.
2. Make use of the tools, drives and clamps indicated in these instructions to avoid possible injury.  
Damage to the test specimen and incorrect settings could also otherwise result.

Continue: A08/2

## SAFETY PRECAUTIONS

3. Attach test-pressure lines perpendicularly to delivery-valve holder and calibrating nozzle holder.  
Non-observance could lead to damage to the connecting nipple of the test-pressure line.  
A damaged connecting nipple may result in the emergence of high-pressure calibrating oil and thus cause injury.

Continue: A09/1



## SAFETY PRECAUTIONS

4. Test-pressure lines which are kinked or damaged at the sealing surfaces of the connecting nipples as well as test-pressure lines with impermissible bending radii are to be replaced (see W 400/000: test benches, test equipment and instructions for testing fuel-injection pumps).

If damaged test-pressure lines are used for testing, this will result in incorrect adjustment. A damaged line can result in the emergence of high-pressure calibrating oil and thus cause injury.

Continue: A09/2

## SAFETY PRECAUTIONS

5. Manually check the fuel-injection pump for freedom of movement before it is driven by the fuel-injection pump test bench.  
If the pump drive or moving parts of the pump has/have seized and the fuel-injection pump is driven, this could result in further damage to the fuel-injection pump and test bench.

Continue: A10/1

## SAFETY PRECAUTIONS

6. The test specimen may only be tested in the prescribed direction of rotation and at the maximum specified speed.

The direction of rotation and the maximum specified speed are given in the appropriate test-specification sheet.

Continue: A10/2

## SAFETY PRECAUTIONS

7. Watch out for moving parts when working with pump housings partially open.

**D a n g e r o f i n j u r y**  
Make exclusive use of prescribed protective devices and tools.

8. Safety goggles are to be worn whilst testing.

Continue: A11/1

## TEST BENCH ACCESSORIES

### For clamping:

- Clamping frames (pair) 0 986 612 544
- Protective device 0 986 612 583

### For driving

- Coupling half, taper  
30 mm diameter 1 686 430 034  
35 mm diameter 1 686 430 038

### For measurement

- CRT measuring device 0 986 612 550
- Prestroke meas. device 0 986 612 570
- Dial indicator 1 687 233 012

Continue: B01/1

## PREPARATION OF FUEL-INJECTION PUMP

Seal off all open bores. This does not however apply to fuel inlet and return bores.

Loosen and unscrew control-rod cap.

Continue: B01/2

Attach appropriate drive coupling to camshaft drive taper.

The drive taper depends on the assembly number in the type designation of the fuel-injection pump.

It should be noted with this type of pump that the control rod is always on the front of the pump. If the assembly number starts with an uneven number, the drive is on the left and on the right in the case of an even number.

Continue: B02/1

## PREPARATION OF FUEL-INJECTION PUMP TEST BENCH

Fuel-injection pumps are only to be tested on the test bench prescribed for the type concerned with appropriate accessories (min. EPS 711).

The calibrating nozzle-holder assembly prescribed for adjustment of the appropriate injection-pump assembly and the test-pressure line as well as the suction gallery pressure and overflow valve are to be taken from the test specifications.

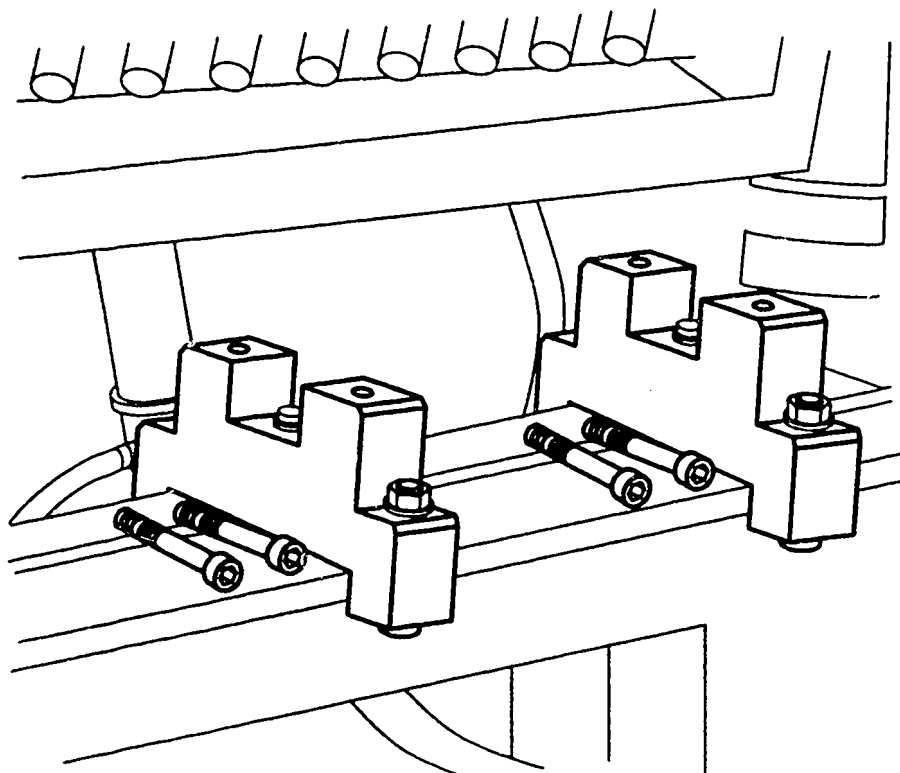
The calibrating oil must be in line with the specifications concerning its test bench applicability (in particular with regard to viscosity).

Continue: B03/1

Place the clamping frames required for clamping the fuel-injection pump in position on the clamping rail of the injection-pump test bench, but do not secure.

Continue: B04/1 Fig.: B03/2

KMK04073



Establish and fit/prepare connection parts (inlet union and inlet-union screw) appropriate to threaded connector of fuel-injection pump and inlet hose of injection-pump test bench.

Continue: B05/1

## **SAFETY PRECAUTIONS**

In addition to the safety instructions given in the operating manuals for Bosch injection-pump test benches, attention is to be paid to the following safety precautions:

1. Never test damaged fuel-injection pumps.
2. Make use of the tools, drives and clamps indicated in these instructions to avoid possible injury.  
Damage to the test specimen and incorrect settings could also otherwise result.

Continue: B05/2

## **SAFETY PRECAUTIONS**

3. Attach test-pressure lines perpendicularly to delivery-valve holder and calibrating nozzle holder.  
Non-observance could lead to damage to the connecting nipple of the test-pressure line.  
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Continue: B06/1



## SAFETY PRECAUTIONS

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If damaged test-pressure lines are used for testing, this will result in incorrect adjustment. A damaged line can result in the emergence of high-pressure calibrating oil and thus cause injury.

Continue: B06/2

## SAFETY PRECAUTIONS

5. Manually check the fuel-injection pump for freedom of movement before it is driven by the fuel-injection pump test bench.

If the pump drive or moving parts of the pump has/have seized and the fuel-injection pump is driven, this could result in further damage to the fuel-injection pump and test bench.

Continue: B07/1

## SAFETY PRECAUTIONS

6. The test specimen may only be tested in the prescribed direction of rotation and at the maximum specified speed.

The direction of rotation and the maximum specified speed are given in the appropriate test-specification sheet.

Continue: B07/2

## SAFETY PRECAUTIONS

7. Watch out for moving parts when working with pump housing partially open.

D a n g e r   o f   i n j u r y  
Make exclusive use of prescribed protective devices and tools.

8. Safety goggles are to be worn whilst testing.

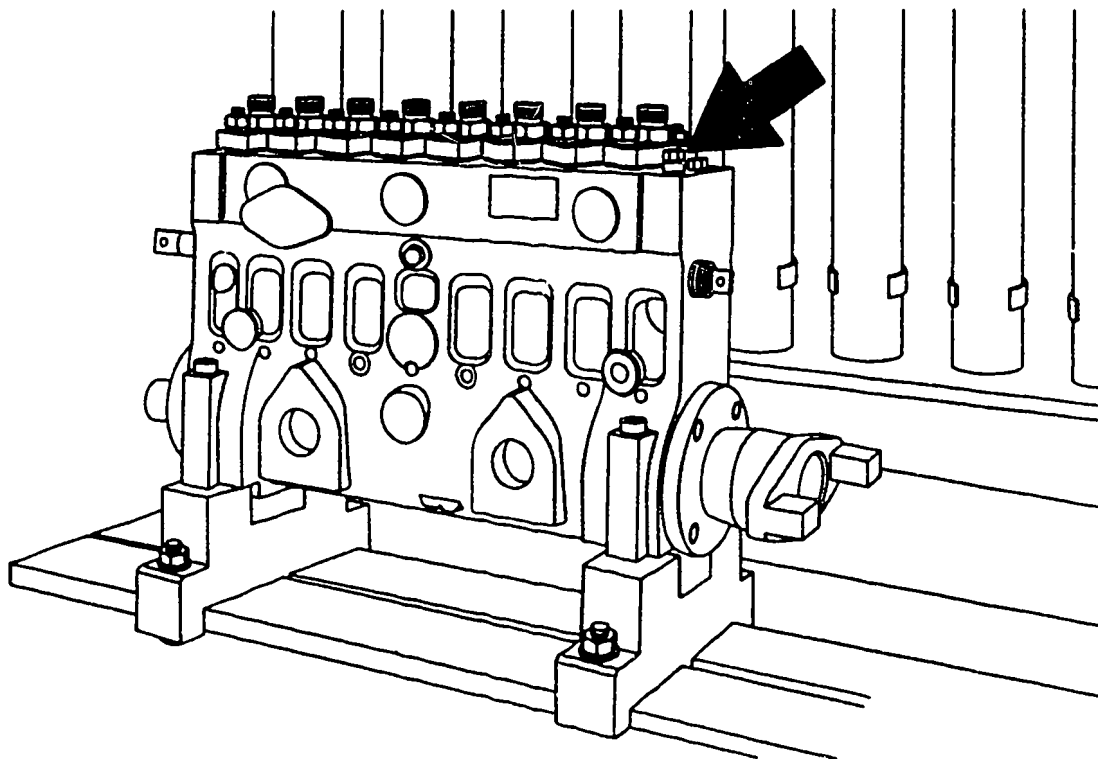
Continue: B08/1

## CLAMPING FUEL-INJECTION PUMP IN POSITION

Place fuel-injection pump to be adjusted on prepared clamps and secure.

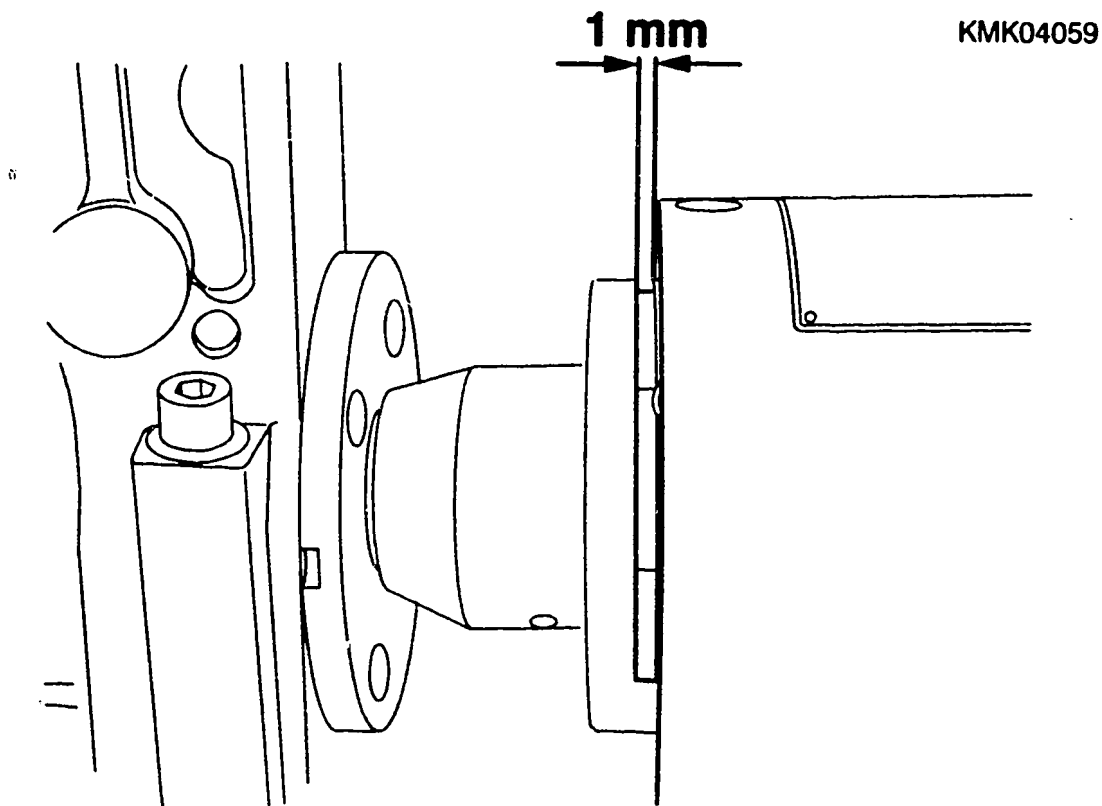
Continue: B09/1 Fig.: B08/2

KMK04067



Push clamped fuel-injection pump in direction of test-bench coupling until claws of coupling half on pump are between clamping jaws of test-bench coupling. There must always be approx. 1 mm between coupling half and clamping jaws (see picture, arrow). Tighten fastening screws of clamping frames. Secure coupling half in test-bench coupling.

Continue: B10/1 Fig.: B09/2

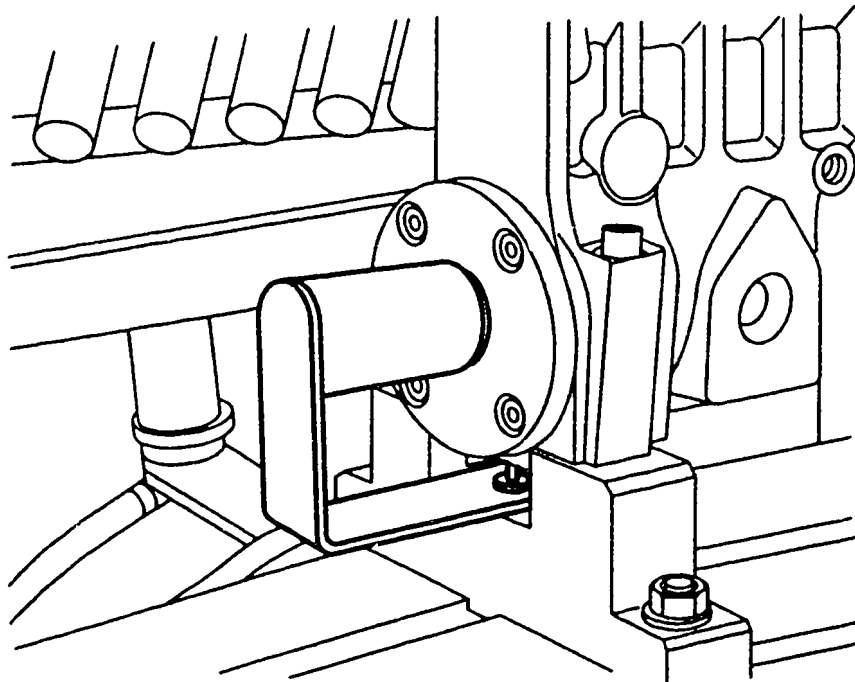


Tighten clamping screws of clamping frames/brackets at clamping rail of injection-pump test bench.

Attach protective device 0 986 612 583 to clamping rail such that end of cam-shaft opposite drive is secured against unintentional contact whilst testing.

Continue: B11/1 Fig.: B10/2

KMK04072



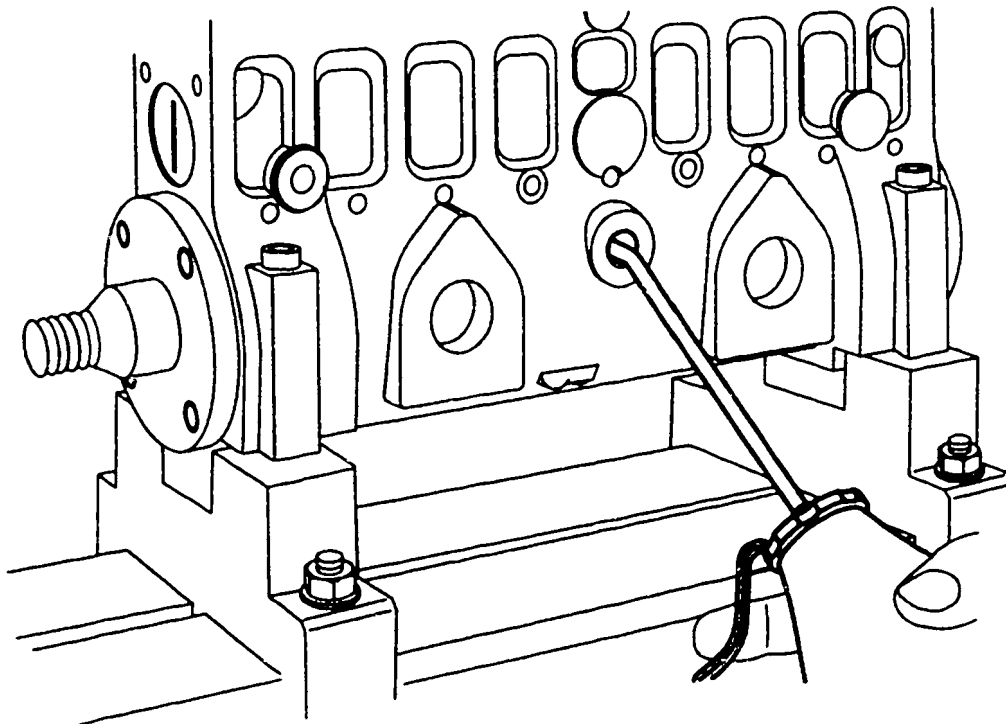
Pour prescribed quantity of lubricating oil (engine oil) through suitable bore into fuel-injection pump (see picture).

The following quantities are prescribed:

- 6 - barrel: 420 ccm
- 8 - barrel: 550 ccm
- 12 - barrel: 800 ccm

Continue: B12/1 Fig.: B11/2

KMK04063



## MEASURING/ADJUSTING PRESTROKE

Take test specifications for corresponding fuel-injection pump from microcard WP..

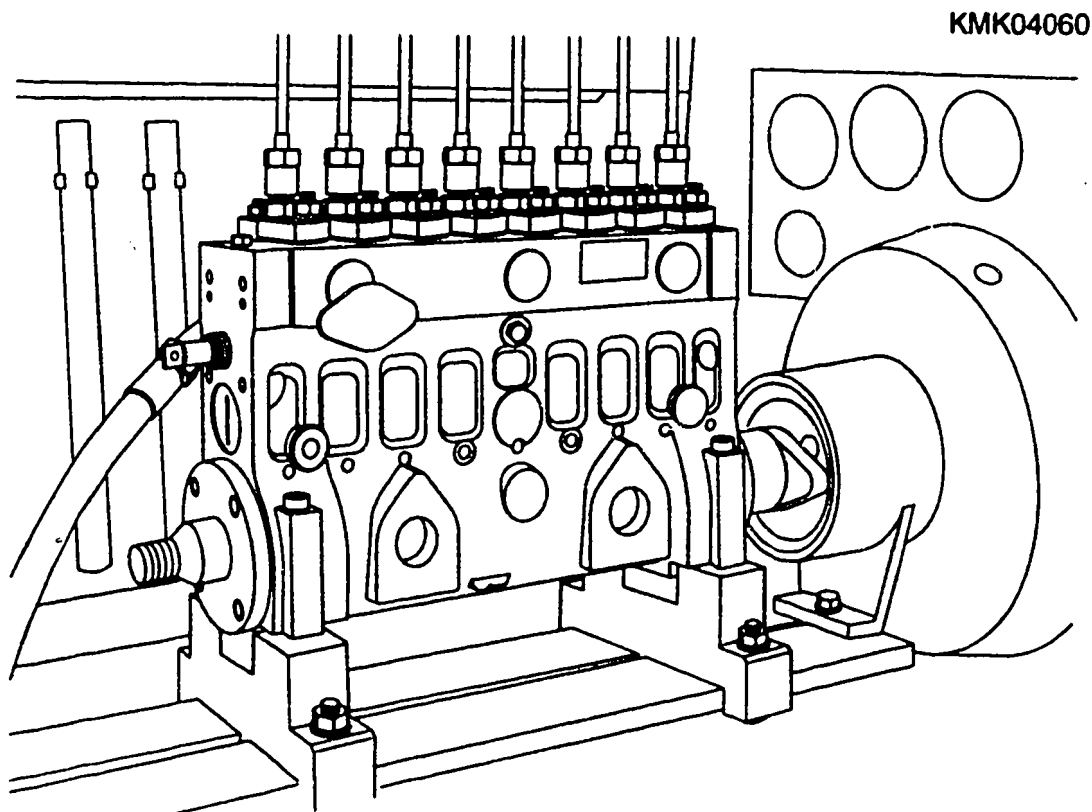
Continue: B13/1

Attach test-pressure lines to delivery-valve holders of fuel-injection pump.

Use suitable inlet-union screw to connect inlet hose of injection-pump test bench to fuel inlet of fuel-injection pump. Other tapped holes in suction gallery of fuel-injection pump, which are used to accommodate overflow valves, are sealed off with screw plugs and copper seal rings.

To make sure that the injection-pump drive does not block, turn camshaft several times by hand by rotating flywheel.

Continue: B14/1 Fig.: B13/2





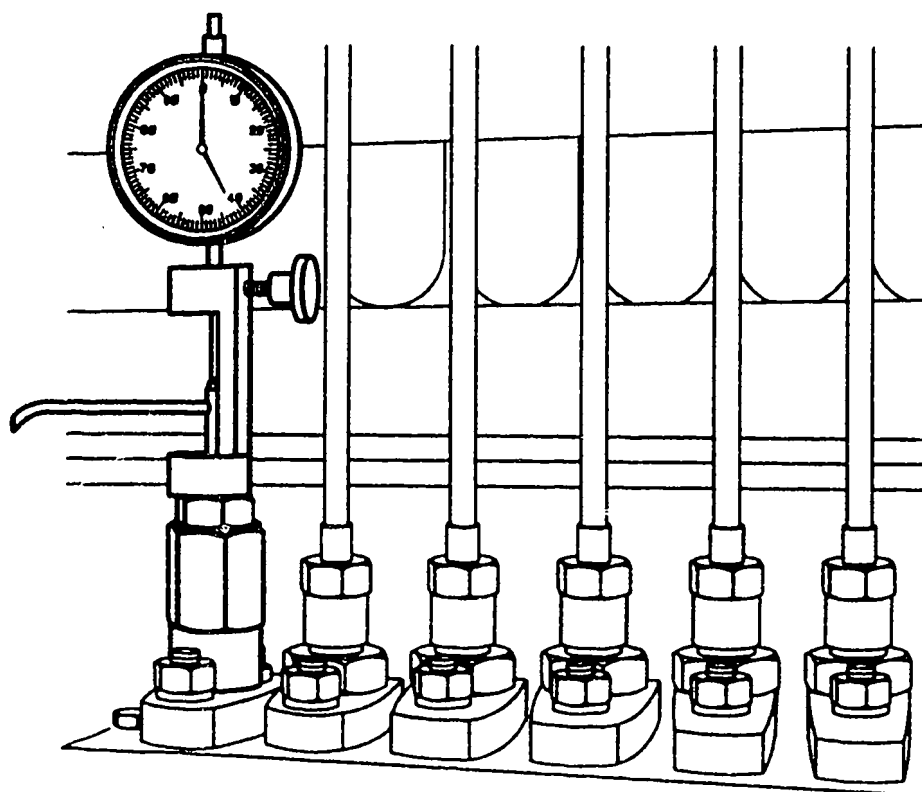
Loosen and screw out delivery-valve holder of pump barrel to be adjusted. Remove delivery valve and keep in a safe place.

Continue: B15/1

Turn camshaft of fuel-injection pump until plunger of plunger-and-barrel assembly envisaged for prestroke adjustment is at BDC.

Screw prestroke measuring device 0 986 612 570 in place of delivery valve and delivery-valve holder into fuel-injection pump and secure. Insert dial indicator 1 687 233 012 into prestroke measuring device and set to "0".

Continue: B16/1 Fig.: B15/2



KMK04062

Turn flywheel of test bench by hand in direction of pump rotation until pump plunger to be adjusted is at BDC. Set dial indicator to "0".

Note:

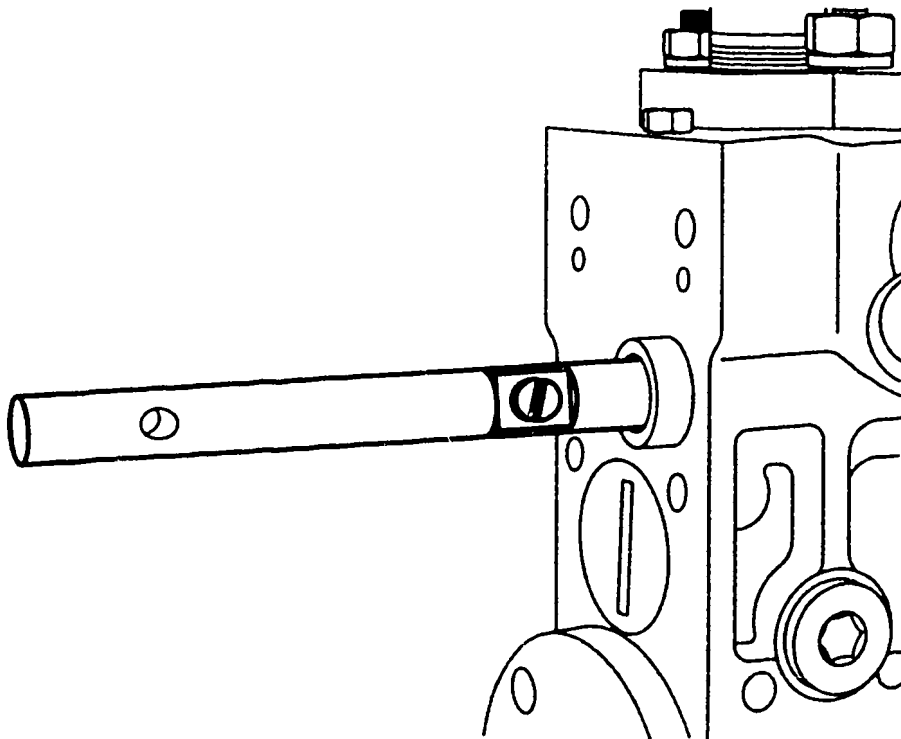
The plunger-and-barrel assembly for prestroke adjustment is to be taken from the test specifications.

Continue: B17/1

Attach CRT measuring device  
0 986 612 570 to fuel-injection pump.  
To do so, secure lifting rod of CRT  
measuring device in position at  
control rod.

Continue: B18/1 Fig.: B17/2

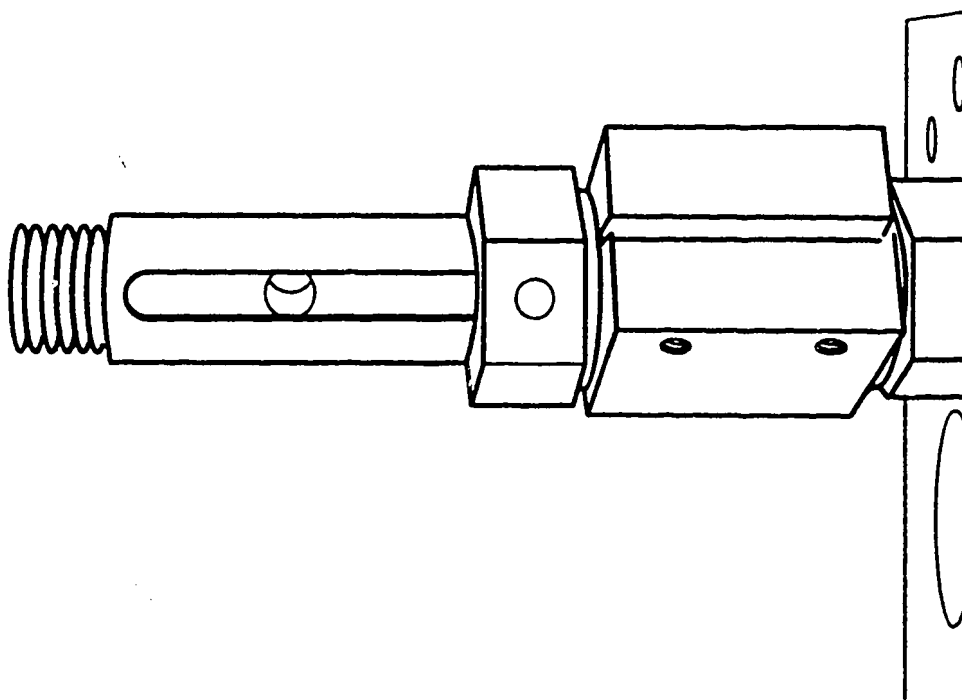
KMK04065



Screw on threaded sleeve of CRT measuring device at fuel-injection pump and attach body of tool without accessories to threaded sleeve such that longitudinal groove in body and transverse bore in lifting rod are in alignment.

Continue: B19/1 Fig.: B18/2

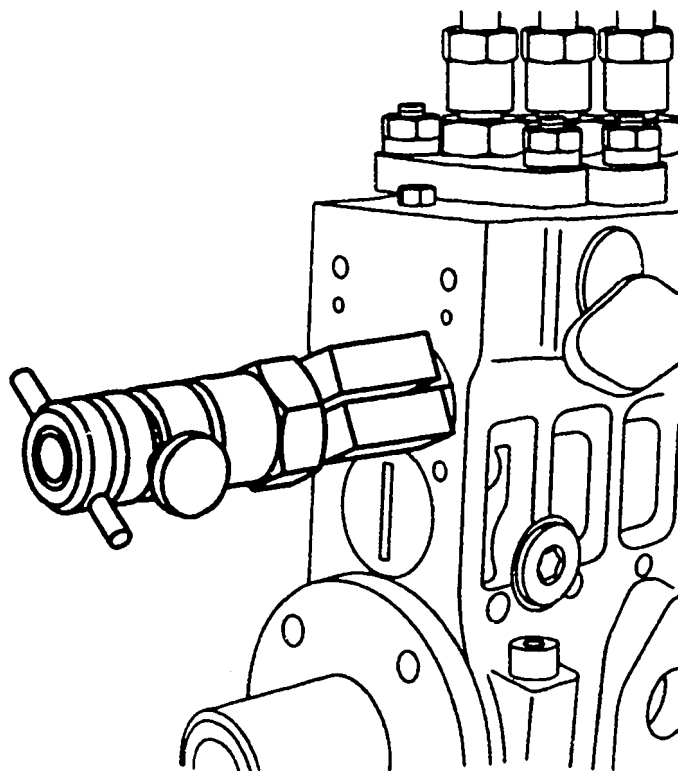
KMK04064



Move control rod to stop position and attach adjustment rings of CRT measuring device such that positioning pin can be inserted into the control rod transverse bore with no play in this control rod position.

Continue: B20/1 Fig.: B19/2

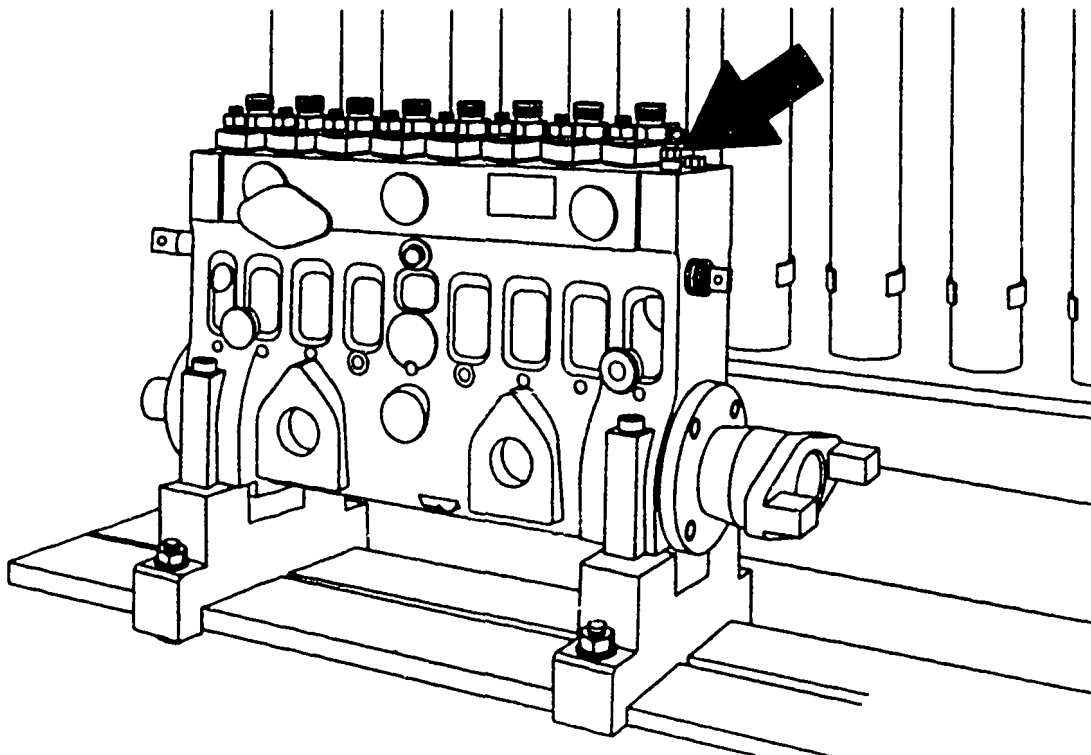
KMK04069



The "0" position is to be set as follows in the case of fuel-injection pumps where the test specification contains the note "CRT 0 is defined with setting of control rod with positioning pin": Screw positioning pin (see arrow) out of pump housing. Remove spacer bushing from positioning pin. Establish control rod position in which positioning pin can be screwed in without spacer bushing. Fix "0" position thus determined on CRT measuring device. Screw positioning pin back out, fit spacer bushing and screw into tapped hole provided.

Continue: B21/1 Fig.: B20/2

KMK04067



Position adjustment rings for overall control-rod travel prescribed for pre-stroke adjustment on CRT measuring device such that insertion of setting pin produces control-rod travel specified for prestroke adjustment.

Continue: B22/1



Switch on injection-pump test bench.  
Increase calibrating-oil pressure  
until calibrating oil begins to flow at  
overflow pipe of prestroke measuring  
device.

Catch calibrating oil in suitable  
vessel.

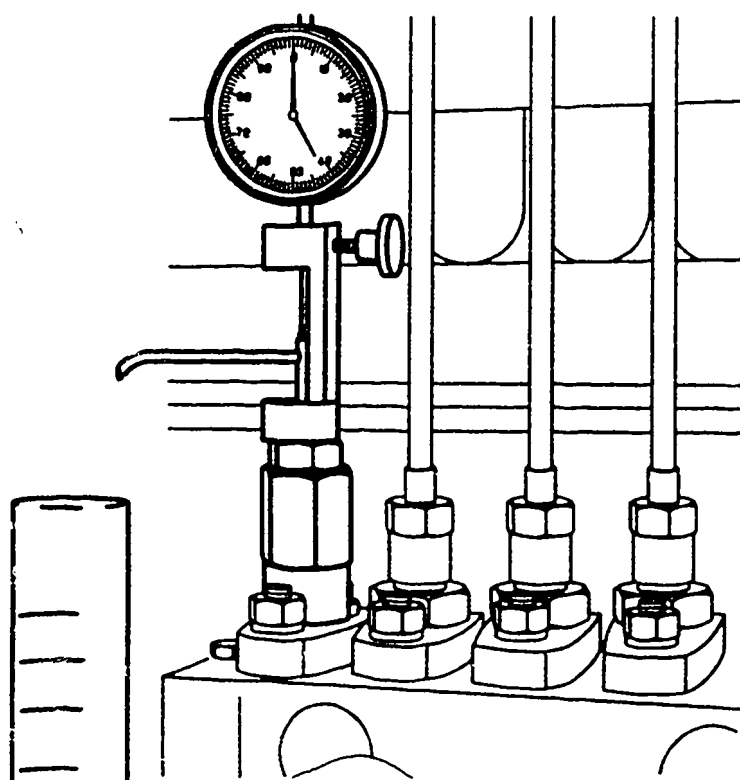
Turn flywheel of injection-pump test  
bench by hand in direction of pump  
rotation.

Note:

The direction of rotation is contained  
in the type designation of the fuel-  
injection pump, example:

FA-PE 8/10/160/900 LS 35. The letter  
after the assembly number (900) indi-  
cates the direction of rotation viewed  
towards the pump drive (R/L = clock-  
wise/counterclockwise).

Continue: B23/1 Fig.: B22/2



KMK04068

Carefully continue turning flywheel of injection-pump test bench until calibrating oil stops flowing at overflow pipe of prestroke measuring device. The prestroke is indicated by the dial indicator of the prestroke measuring device.

Compare this prestroke to that stipulated in the test specifications.

Continue: B23/2

Proceed as follows if the reading does not tally with the value given in the test specifications:

Switch off injection-pump test bench. Loosen securing nuts of flange bushing of plunger-and-barrel assembly.

Continue: B24/1

Raise barrel-and-valve assembly slightly after loosening securing nuts and take out prestroke shims. Replace prestroke shims with two identical shims of different thickness.

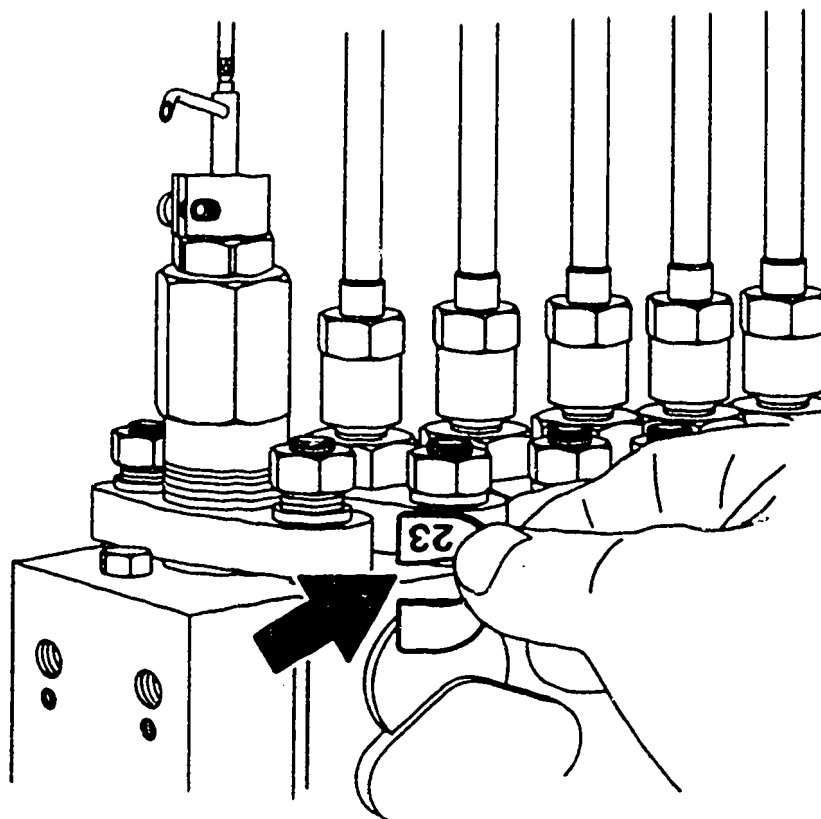
The thickness of the shim to be used depends on the difference in size between the prestroke prescribed and that determined. If the measured prestroke is larger than that stipulated in the test specifications, fit thinner prestroke shims and vice versa. Always make sure that use is made of two shims of equal thickness.

Continue: B25/1

The thickness is marked on the pre-stroke shim, e.g. 23 = 2.3 mm (see arrow).

Press barrel-and-valve assembly back into fuel-injection pump as far as it will go and tighten securing nuts to prescribed torque.

Continue: B26/1 Fig.: B25/2



KMK04061

Switch on injection-pump test bench and establish prestroke by manually turning flywheel of injection-pump test bench as specified. Repeat prestroke adjustment if the value still does not tally with the test specifications.

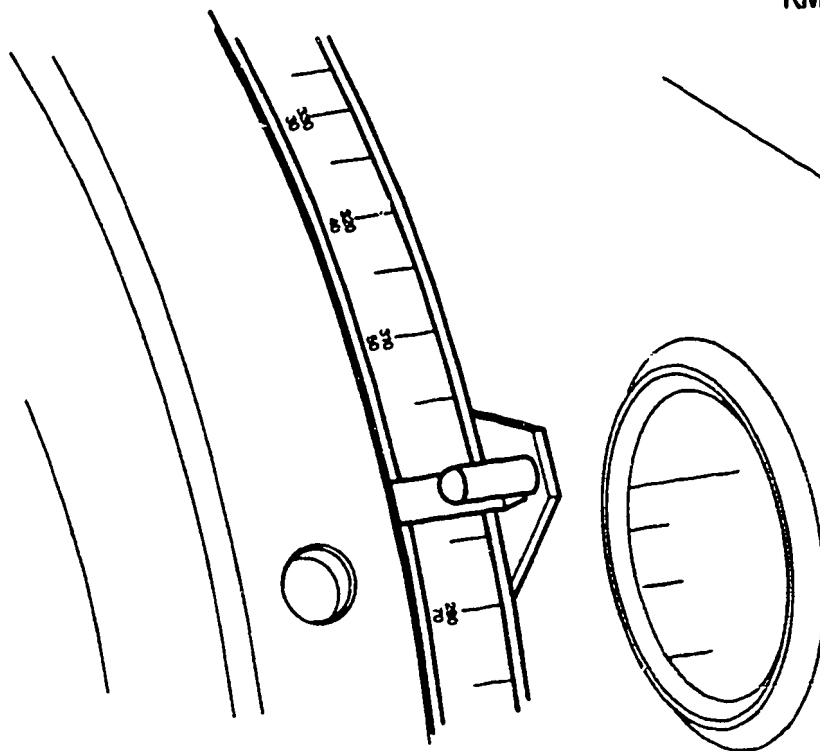
If the prestroke adjustment is correct, initially hold flywheel in this position and set pointer on flywheel of injection-pump test bench to an "even" value (increment of ten).

This facilitates subsequent measurement of the port-closing difference.

Remove prestroke measuring device.

Continue: B27/1 Fig.: B26/2

KMK04070



Install delivery valve with new soft-iron seal ring and delivery-valve holder in fuel-injection pump. Tighten delivery-valve holder as described:

with flat seal ring and gripping edge:

180...200-0-160...180 Nm

with flat seal ring and beaded seal ring:

180...200-0-180...200-0-38...42 Nm

+ 20...21 Grad turn-on angle with two gripping edges (no seal ring):

160...180 Nm

Attach test-pressure line to delivery-valve holder.

Continue: B28/1

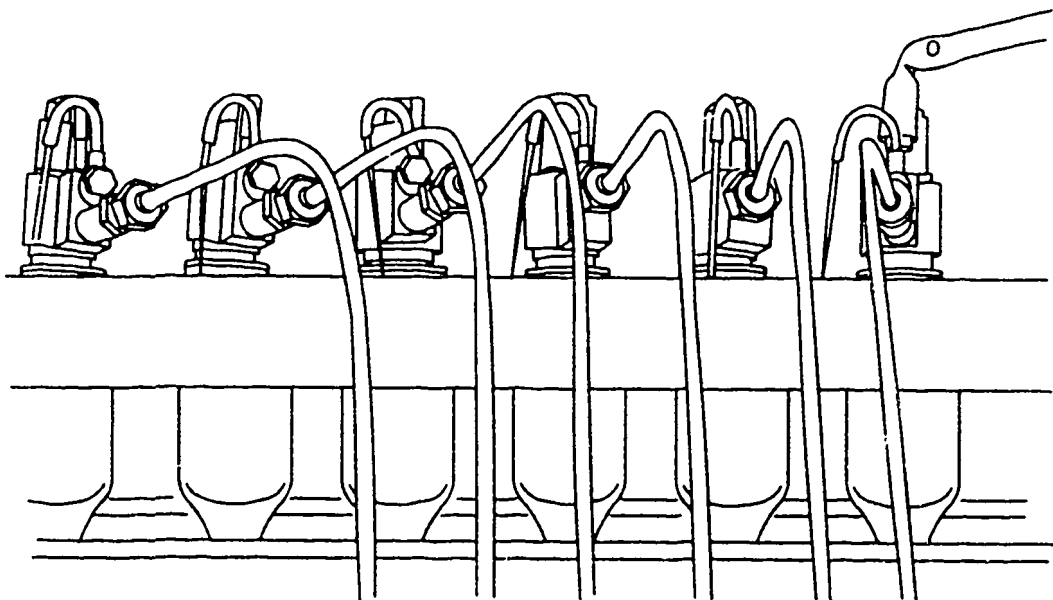
## ADJUSTMENT OF PORT-CLOSING DIFFERENCE

Open screw plugs of overflow pipes of all calibrating-nozzle holders (see picture).

Move control rod to stop position. Switch on injection-pump test bench and set calibrating-oil high pressure. Calibrating oil emerges from the overflow pipes of the calibrating-nozzle holders. The initial foaming must slowly tail off. Once the calibrating oil starts to emerge without foam, switch off injection-pump test bench and close screw plugs of overflow pipes again.

Continue: C01/1 Fig.: B28/2

KMK04075



Move control rod to prescribed pre-stroke adjustment position and secure this position on CRT measuring device. Open overflow pipe of next barrel in cam sequence. Turn camshaft in prescribed direction of rotation until flow of calibrating oil at overflow pipe becomes a chain of droplets.

Read off degrees on pointer at flywheel of injection-pump test bench and subtract value from figure thus determined (to which pointer was previously set in start-of-delivery position of preceding barrel).

Continue: C01/2

Example:

Cam sequence 1-5-3-6-2-4

Port-closing difference:

0-60-120-180-240-300-360 Grad  
cam angle (NW)

Barrel 1 start of delivery resulted in pointer position 130 Grad (1)

Barrel 5 start of delivery resulted in pointer position 191 Grad (1)

Value (1) subtracted from value (2) = 61 Grad NW.

I.e.: Port-closing difference from barrel 1 to barrel 5 equals 61 Grad. Note down this value.

Continue: C02/1



Then proceed in the same manner with the remaining barrels and enter the values determined in the test record. It should be noted that the angular cam spacing is not to be measured from barrel to barrel, but rather always referenced to the first barrel set. The figure given in the test specification is thus: 0-60-120-180 etc. and not: 0-60 etc. for every 60 Grad.

Continue: C03/1

Where appropriately indicated under "Remarks" in the test specification, the prestroke and angular cam spacing are measured as follows in the case of fuel-injection pumps with constant-pressure valves:

Switch on injection-pump test bench. Increase pressure of calibrating oil until calibrating oil starts to flow at overflow pipe of prestroke measuring device.

Catch calibrating oil in suitable vessel.

Turn flywheel of injection-pump test bench by hand in direction of pump rotation.

Continue: C03/2

Carefully continue turning flywheel of injection-pump test bench until calibrating oil stops flowing at overflow pipe of prestroke measuring device. The prestroke is indicated by the dial indicator of the prestroke measuring device. Note down this value. Measure all subsequent barrels in the same way.

If necessary, correct prestroke adjustment by adding appropriate shims (in pairs) beneath flange of plunger-and-barrel assembly.

Enter final prestroke value in record.

Continue: C04/1

Check on angular cam spacing:  
All delivery valves installed and  
delivery-valve holders properly  
tightened.

Screw all test-pressure lines with  
calibrating-nozzle holder assembly to  
delivery-valve holders and then vent.  
Close off all overflow pipes. Over-  
flow pipe of prestroke adjustment  
barrel remains open. Turn camshaft in  
prescribed direction of rotation  
until flow of calibrating oil at over-  
flow pipe becomes a chain of droplets.  
Set pointer of flywheel of injection-  
pump test bench to "0".

Continue: C04/2

Close off overflow pipe and establish  
angular cam spacing of remaining  
barrels in same manner.  
If the angular cam spacing is outside  
the permitted tolerance, the fuel-  
injection pump is to be disassembled  
and the camshaft renewed.

Continue: C05/1

## CHECKING AND ADJUSTING BASIC SETTING

Overflow pipes of all calibrating-nozzle holders closed off.

Connect up calibrating-oil return hose with the overflow valve stipulated in the test specifications to the envisaged tapped hole.

Switch on injection-pump test bench and set inlet pressure prescribed in test specification. Warm up calibrating oil until inlet temperature stipulated in test specifications is reached.

Continue: C05/2

Push control rod of fuel-injection pump out of stop position in "Full" direction until control-rod travel prescribed in test specification is attained. Fix control rod in this position by setting it at CRT measuring device. Drive fuel-injection pump at speed stipulated in test specifications. Set stroke counter to "100" and switch it on. The calibrating oil collected in the graduates of the test bench is only used with the first measurement for wetting the graduates. These are then to be emptied again. The runout time is 59 - 61 seconds.

Continue: C06/1

If the interval between runout and the next measurement is more than 10 minutes, the graduates must be moistened again.

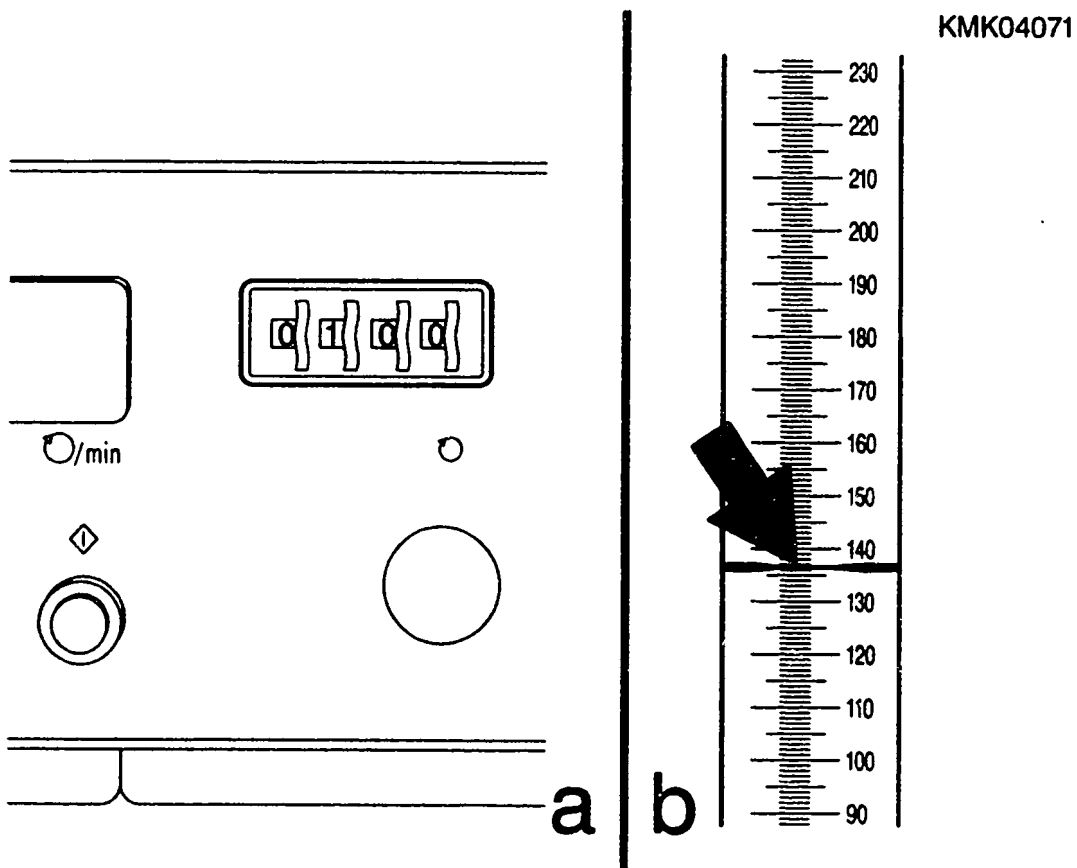
Leave stroke counter set to "100" and trigger.

Once the stroke counter has completed measurement, read off and note down amount of calibrating oil in each graduate.

Continue: C07/1

Exact reading is guaranteed by a blue stripe on the graduate opposite the numbers (see picture, arrow).  
 When graduate is wet, refraction on surface of liquid produces two peaks one on top of the other. The delivery is always to be read off from the scale division indicated by the two peaks.

Continue: C08/1 Fig.: C07/2



The delivery indicated in the test specifications is the average figure for all individual delivery rates determined. It must also be established whether or not the scatter permitted by the test specifications is exceeded. The scatter signifies the difference in quantity between the largest and smallest rate.

Example:

Prescribed delivery = 52.1...52.3 ccm/  
100 strokes

Permitted scatter = 0.3 ccm/100 strokes

Continue: C09/1

Barrel No.	Delivery ccm/100 S	Average ccm/100 S
1	52.4	
2	52.2	
3	52.5	
4	52.3	
5	52.5	
6	52.4	52.38

Continue: C09/2

Scatter determined:  $52.5 - 52.2 = 0.3$   
ccm/100 strokes

This setting is not permitted; the  
average value of all barrels is not  
between 52.1 and 52.3 ccm/100 strokes.

Continue: C10/1



Barrel No.	Delivery ccm/100 S	Average ccm/100 S
1	52.4	
2	52.2	
3	52.0	
4	52.3	
5	52.1	
6	52.4	52.23

Continue: C10/2

Scatter determined:  $52.4 - 52.0 = 0.4$   
ccm/100 strokes

This setting is not permitted; the  
scatter is more than 0.3 ccm/100  
strokes.

Continue: C11/1

Barrel No.	Delivery ccm/100 S	Average ccm/100 S
1	52.4	
2	52.2	
3	52.2	
4	52.3	
5	52.1	
6	52.4	52.26

Continue: C11/2

Scatter determined:  $52.4 - 52.1 = 0.3$   
ccm/100 s'trokes

This setting is permitted.

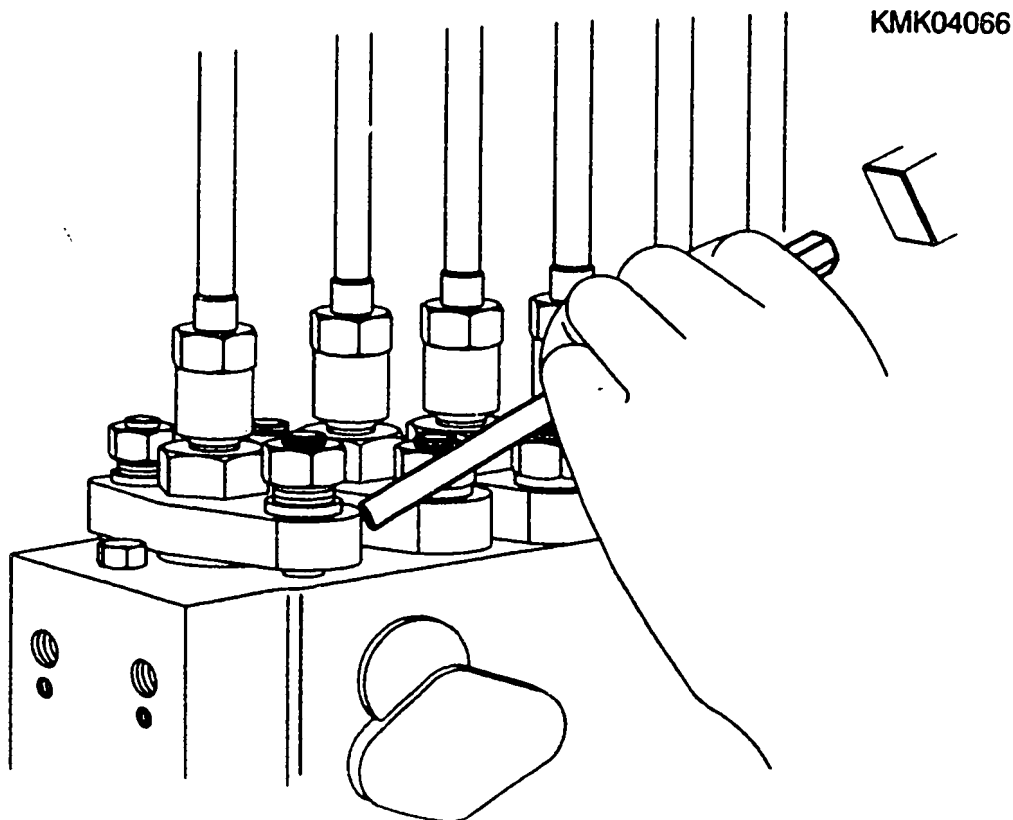
Continue: C12/1

Proceed as follows if the adjustment of the fuel-injection pump has to be improved on account of impermissible values:

Switch off injection-pump test bench. Loosen hexagon nut of flanges of plunger-and-barrel assemblies. Correct delivery of individual plunger-and-barrel assembly by turning barrel-and-valve assembly within adjustment range of slots. This can be done by tapping gently on the flange with a mandrel to obtain the necessary correction.

Following adjustment, retighten hexagon nuts of barrel-and-flange elements to 51...58 Nm.

Continue: C13/1 Fig.: C12/2



Then measure delivery again at prescribed speed. Perform renewed correction if the specified values are still not attained.

Basic adjustment is followed by testing of the values given in the test specifications as further basic settings at the prescribed speed and with the corresponding control-rod travel. The following are possible causes if the delivery rates stipulated in the test specification sheet are not obtained:

Continue: C13/2

- + Use of incorrect or non-serviceable plunger-and-barrel assemblies
- + Use of incorrect or non-serviceable delivery-valve assemblies
- + Incorrect delivery-valve springs and/or filler pieces in delivery-valve holder
- + Incorrect or non-serviceable (cavitation) delivery-valve holders

Continue: C14/1

Perform delivery check. Correct again if necessary until prescribed delivery is attained.

Remove CRT measuring device. Screw control-rod closure cap to fuel-injection pump and tighten to max. 30 Nm.

Pull drive coupling off camshaft.  
Remove protective device 0 986 612 583 from injection-pump test bench.  
Completely assemble fuel-injection pump.  
Unclamp fuel-injection pump from the injection-pump test bench.

Continue: N26/1

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## EDITORIAL NOTE

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